Name _____ AP Chemistry

Determination of the Solubility Product of an Ionic Compound

Introduction

The solubility product constant (K_{sp}) is a particular type of equilibrium constant. The equilibrium is formed when an ionic solid dissolves in water to form a saturated solution. The equilibrium exists between the aqueous ions and the undissolved solid. A saturated solution contains the maximum concentration of ions of the substance that can dissolve at the solution's temperature. The equilibrium equation showing the ionic solid lead chloride dissolving in water is:

$$PbCl_2\ (s) \leftrightarrow Pb^{2+}\ (aq) + 2\ Cl^-\ (aq)$$

The solubility product expression is $K_{sp} = [Pb^{2+}][Cl^-]^2$ where square brackets refer to molar concentrations of the ions. Knowledge of the K_{sp} of a salt is useful in determining the concentration of ions of the compound in a saturated solution. This allows us to control a solution so that precipitation of a compound will not occur, or to find the concentration needed to cause a precipitate to form.

In this experiment, solutions of calcium ions and hydroxide ions are mixed to form a precipitate of calcium hydroxide. The solutions are each diluted and mixed until a precipitate no longer appears. The solubility product for calcium hydroxide is then calculated from the solution concentrations.

Procedure

1) Obtain a microplate along with a small beaker of 0.10 M $Ca(NO_3)_2$ and 0.10 M NaOH along with some disposable pipettes.
2) Add 5 drops of 0.10 M $Ca(NO_3)_2$ in well #1. Then place 5 drops of DI water in each of the other eleven wells.
3) Add 5 drops of 0.10 M $Ca(NO_3)_2$ to well #2. Using a disposable pipette, mix the solution in well #2.
4) Add 5 drops of the solution in well #2 to well #3 using the same disposable pipette. Place the remaining solution back into well #2.
5) Mix well #2 as in step 3.
6) Wash your pipette in a beaker of water to clean your pipette.
7) Repeat steps 3-6 for wells #3-12. For well #12, discard 5 drops.
8) Now add 5 drops of 0.10 NaOH to each well. Use a toothpick to mix each well.

9) Allow three or four minutes for the precipitates to form. Note which well the first not to produce a precipitate under Results.

Results

First well with no precipitation: _____

$[Ca^{2+}]$ = _____ M

$[OH^-]$ = _____ M

K_{sp} $(Ca(OH)_2)$ = _____

Calculations/Postlab Questions

1) Using the concentration of $[Ca^{2+}]$ ions in well #12 is 2.4×10^{-5} M, calculate the concentration of Ca^{2+} ions for the first well without precipitation (Hint: you made a serial dilution in the wells so each well is half the concentration of the previous). Record it in the Results.
2) Calculate the $[OH^-]$ ions using the information that 5 drops of 0.10 NaOH was added to 10 drops of solution. Record it in the Results.
3) Using the $[Ca^{2+}]$ and $[OH^-]$, calculate K_{sp} for $Ca(OH)_2$. Record it in the Results.
4) Look up the solubility product of calcium hydroxide and compare your value to the accepted value.